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"GLEANINGS FROM OUTCROPS OF SILURIAN STRATA IN THE RED RIVER VALLEY."

—BY—

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GLEANINGS FROM OUTCROPS

Of Silurian Strata in the Red River Valley, Manitoba.

Early in the autumn of 1883 I made my first visit to Selkirk for the purpose of examining rocks exposed in that vicinity. To my surprise I found the remains of primeval life exceedingly numerous in the rock that was being quarried. Struck with the profuseness of fossils, I at once concluded that the Silurian strata of the Red River Valley would afford prolific results if made an object of research.

My occupation during the summer of 1883 was such that I was unable to make but a few visits to neighboring exposures. But the present year (1884) brought more leisure for scientific research, better opportunities and greater facilities for a thorough examination of these strata. Besides, a personal examination of the various outcrops described in this paper, on which occasions I have had excellent opportunities to examine the rocks *in situ*, there has also been examined a very large quantity of stone brought to Winnipeg from the quarries and used both for ordinary building purposes and as stone to be "dressed" for ornamental work. The "dressing" of these stones has opened up a treasure-house of fossil wealth. Many of them in the rough are very large, and require to be split up into smaller pieces before being dressed. As these have been opened, some most interesting specimens of primeval life have been revealed. Nearly every day during the present summer the buildings in course of erection have been visited, and scarcely has a single visit been made without some information gained regarding the Silurian fossils of these rocks.

In placing the results of my investigations before you, I purpose describing groups of outcrops that are somewhat uniform in their lithological and palæontological characters, and enumerate the fossils found in them. After which to give some conclusions arrived at from the consideration of the whole. The accompanying sketch map represents the location of the seven outcrops described in this paper.

(A sketch map showing the position of the exposures was on exhibition.)

EXPOSURE 1.

This quarry, situated on the east side of the Red River about 21 miles northeast of Winnipeg, is but a short distance from Selkirk station, on the Canadian Pacific Railway, and about one-half mile from the river. The exposure is not very extensive as yet, the quarry being opened but a comparatively short time. As you approach this place from the station you perceive that there is a slight elevation well defined in the vicinity of the outcrop. Looking at the face of the rock you observe that the strata are covered with

about four feet of loose drift in the southern part, but full ten in the northern. In this are numerous boulders, a few gneissoid, but most of them the same material as the solid rock, and of a more or less angular nature. The strata on the east side is quite horizontal, but on the west very much tilted. There appears to be a break through the centre of the quarry, indicating a marked upheaval at one time. This likely took place after the glacial period, for the glacial drift is deposited quite irregularly over the disturbed rock.

On the west side there are immense fragments lying at an angle of 45° with vacant spaces like caves below them. From the raised appearance of this part it seems as if the apparent mound over the quarry has had its origin in this upheaval.

Fossils appear after the first layer of rock is removed. No part of the quarry as yet seems more prolific than another. The layers of rock are about 2 feet thick, and exposed to a depth of 12 feet. Neither from personal observation nor from questioning the workmen have I been able to ascertain that certain fossils characterise particular beds. The most casual observer could not fail to observe the fossils on the stones of this place. Remains of Cephalopods Corals and the genus Receptaculites are seen on every side, the last being exceedingly common. The Cephalopods are numerous and large—several 5 to 7 inches in diameter have been observed.

The rock from this place is largely used in Winnipeg for ornamental stone. Being comparatively soft it "dresses" readily and takes a good finish and when burnt produces a very white lime. It is of a greyish white color and effervesces strongly on treatment with cold Hydrochloric acid. It presents a peculiar mottled-like appearance which adds much to its beauty as an ornamental stone. This strange mixture of brown and white is difficult to account for. In some cases it appears as if its origin might be due to seaweed remains. Often the colored portion approaches the color of yellow ochre and seems strongly impregnated with iron, while the intervening spaces are more or less colored. So marked is this mottled condition that the stone from Selkirk district can be distinguished at once from the rock described in a subsequent part of this paper. Of the various exposures visited this has afforded the best results, and as already remarked the fossils cannot be connected with particular beds but are found within a thickness of 10 feet. In several of the thick fragments of rock though no lines of stratification can be seen, still in many cases they readily split. When this is done peculiar markings are frequently observed. These appear to be the remains of plant-life. Portions of stems can be made out, but the whole are in a confused condition and no definite characters are discernible. Notwithstanding fossils are numerous in this limestone and in many cases their generic characters easily observed yet we often find the specific comparatively obscure and difficult to identify.

EXPOSURE 2.

This quarry is about half a mile northwest of No. 1, and situated nearer the town of East Selkirk on the west side of the Railway track. Here the rock is not so near the surface as in the preceding, but covered with about 20 feet of *drift* material which renders it more difficult to quarry the stone. The *drift* is full of large boulders of the same material as the solid rock below.

These are taken out and shipped to the city. Only a few feet of the solid rock has been worked, and though many fragments are lying about, yet they do not appear as prolific in fossils as at the rock at the former quarry.

The stone is the same as already described in general appearance, but is said to be slightly softer and preferred by stone-dressers.

EXPOSURE 3.

This outcrop is situated on the west bank of the Red River a short distance south of what is known as the "Stone Fort," and about 4½ miles southwest of the places already referred to. Here the rock is on the bank of the river 5 feet above the water level. About 15 feet of *drift* overlies the stone. This rock while to a great extent it resembles in external characters that from exposures 1 and 2 seems to be harder, but breaks very readily, and in some cases presents a conchoidal fracture.

A large quantity of this stone was quarried during the past winter and conveyed to Selkirk to be used in the erection of the provincial asylum. I had an excellent opportunity of examining this stone on the asylum grounds, where large quantities of it was lying. Whether the fact of its being quarried in winter affected its condition I am not prepared to say, but it certainly possessed some characters differing much from the rock at East Selkirk. The stone-cutters pronounced it a very fine rock to work and much superior to any of the Red River stone they had dressed.

Very little could be seen at the quarry. The surface had fallen into the excavation during the spring and covered up the rock, but during several examinations at the public buildings some very fine specimens were obtained. Fossils were very common and peculiar in as much as they were in some cases like those found at Stony Mountain in an entirely different kind of rock, thus forming a sort of transition between the rocks at Selkirk East, 4 miles further down the river, and those of the mountain situated several miles west of it. This is an important point and well worthy the attention of future investigators.

Orthis testudinaria, chætetes lycoperdon and one imperfect specimen of the genus Rhynchonella, common fossils at Stony Mountain, were found at this place.

Several masses of a coral apparently of the genus Diphyllum were found here only. Crinoid stems and some fragments of Polyzoa were also observed.

I was very much surprised at the results obtained from this outcrop, for I had found none of the above mentioned at either of the East Selkirk exposures, and am inclined to consider this a connecting stratum between those of Stony Mountain and East Selkirk.

Mr. McCharles, of Winnipeg, has found specimens of the genus Spirifera here, but as the stone containing them was a rounded fragment it may have come from elsewhere, probably the Deronian rocks, supposed to lie west and north of this part.

EXPOSURE 4.

This is still farther south, being about four miles up the river. In this vicinity numerous limestone boulders are found.

These are much the same in character as the rocks of the preceding quarries. They are frequently collected by farmers in the neighborhood and used in making lime.

At places near the water's edge the rock appears, and fragments which have been scattered along the river, and more or less waterworn, often show very well defined fossils, especially of the genus Orthoceras, much "weathered" and very distinct.

No large exposure occurs in any part like those of outcrops 1, 2, 3, as no stone is quarried at present in this district, but it is evident from the innumerable limestone boulders scattered along the river that rocks *in situ* are not far below the surface. These exposures show that this band of mottled whitish grey rocks extends at least in width for a distance of 8 miles, and that this rock is very uniform in its external character.

The following is a list of fossils obtained from the outcrops referred to as Exposures 1, 2 3, 4. Although I have had access to Hall's admirable works on Silurian fossils, and reports published by the Canadian Geological Survey, I am at a loss to identify many of the specimens found in the rocks of these outcrops near Winnipeg.

PLANTÆ.

1. Palæophycus.—Though not well defined in specific characters, it can be readily recognized as plant remains.

PROTOZOA.

2. Receptaculites.—This genus is one of the most common fossils at these exposures. They vary from 5 to 10 inches in diameter. There is scarcely a large stone but shows several specimens. In every case the specific characters are very obscure. Although I have seen innumerable specimens none as yet have been observed that gave the least indication "of a great central cavity," as stated by Billings in his description of this genus. Every one is circular, none less than 5 inches in diameter and usually about 7-9 lines thick. The external and internal integuments are distinct and the peculiar tubular skeleton very marked. The rhomboidal plates are readily perceived and the rounded protuberance on the lower side easily seen.

It is difficult to get complete specimens out of the rock, as they almost invariably break up owing, no doubt, to their discoidal form and comparative thinness.

The species common here is likely Receptaculities Oweni, (Hall.)

3. Stromatopora rugosa (Hall)—A specimen some 5 inches in diameter seems to be of this species.

4. Stromatopora.—An entirely different form from the preceding also occurs. In this the laminæ numbering 4 to the line are well marked, and present a wave-like appearance. Three distinct crests are shown in one specimen On the surface above these are several apertures, around which the laurmæ present a series of concentric rings. This wave-like arrangement has been observed on several specimens, and seems to be a characteristic of the species.

5. Stromatopora.—Another form which in some respects agrees with the description of S. mammillata, by Nicholson. On the surface are conical elevations, and the whole covered wite stellate markings.

CŒLENTERATA.

6. Columnaria alveolata (Hall).—Very common and in large masses.
7. Halysites catenulatus (Linnæus)—Also common. Some specimens very large, over a foot in diameter. A variety of this species with small corallites has been found.
8. Columnopora cribriformis (Nicholson).—Quite common. The lace-like structure of the corallites and stellate appearance on the surface make it one of the most beautiful corals found in the Selkirk limestone.
9-11. Zaphrentis,—Common in three forms. Each likely represents a different species. One shows a distinctly quadrilateral outline in a transverse section. Another exhibits a short but expanded cup, while the third is much longer and tapers more gradually to a point.
12. Heliolites pyriformis (Hall).—Bears a marked resemblance to one species found at East Selkirk.
13. Tetradium fibratum (Stafford).—Very well marked.
14. Chætetes lycoperdon (Hall).—Found only at exposure 3.
15. Diphyllum.—Also restricted to the same place. Large masses found.
16, 17. Besides these, two other species of coral seem to be present or allied to Favosites, the other to Syringopora. This gives us at least 12 species of coral from the Selkirk rocks, and there is no doubt others will be obtained on further investigation.

ANNULOIDA.

18. The only representatives of this subkingdom are fragments of Crinoidal stems, which resemble those of Schizocrinus nodosus (Hall.).

ANNULOSA.

Several fragments of trilobites have been obtained. These appear to be the remains of at least four species.
19. Cheirurus.—A well defined glabella.
20. Illænus.—Several pygidia and a few body segments.
21. Platynotus Trentonensis (Hall).—Several heads found resemble those of this species.
22.—Phacops.—The specimen obtained bears a close resemblance to the cephalic region of this genus.

MOLLUSCA.

This subkingdom is sparingly represented in numbers except among the cephalopods, which are exceedingly numerous and very large forms, some several feet in length and nearly a foot in diameter.
23. Several fragments of forms belonging to the Polyzoa.
24. Strophomena alternata (Conrad).—Several.
25. Leptaena sericea (Sowerby).—Found at the "Fort."
26. Strophomena teunistriata (Hall.)
27. Orthis testudinaria (Hall).—Peculiar to the Lower Fort.

28. Rhynchonella increbescens (Hall.)—Found at the same place.
29. Pleurotomaria subconica (Hall.)
30. Pleurotomaria umbilicata (Hall.)
31. Murchisonia bellicincta (Hall.)
32. Murchisonia subfusiformis (Hall.)
33. Maclurea.—Several specimens have been found by the writer. One of these is very large and well preserved. Its widest diameter is 9½ inches. From the lowest and perfectly flat side to the summit of the convex is 2½ inches. Of the others none exceed 5 inches at the widest point.
34. Orthoceras.—This genus is represented by several species in the Selkirk limestone, some of which are very large. One found is 10½ inches wide at the well marked body chamber, 9½ inches in length. Thirty-six segments are in view in a space of 13 inches. At the last of these the specimen is 8 inches wide.

This seems to be complete, and differs markedly from other forms in which the segments diminish in size until the fossil tapers to a point and presents a wedge-like form. Large fragments of this genus are common.

35. Ormoceras.—Several beaded siphuncles, apparently of this genus have been found.
36. Cyrtoceras.—This genus is represented by several fragmentary specimens which show a distinctly curved form. The largest is 8 inches along on convex side, 5½ on the concave.

They are readily distinguished from the large forms of Lituites 3 and 4 feet in length.

37. Phragmoceras Hector, (Billings)—A specimen in the writer's possession closely resembles this. 8 segments are distinct. The siphuncle is readily seen on the concave side and the large chamber well defined. But there is no indication of the peculiarly contracted aperture of the shell. This may be a different species but it seems to resemble this more than others examined.
38-39. Lituites—Some very large specimens have been found which appear to be of this genus. Two species at least are represented. One closely allied to, if not L. undatus, the other L. convolvans of Hall. One of these specimens is 36 inches in circumference. The diameter of the shell at the body cavity is 5½ inches. Septa distinct after a thin striated covering is taken off.

This shell-like covering is invariably found on the specimens, but often cracks off when trimming the rock. These large forms are the most imposing cephalopod fossils in the Selkirk stone. None were observed by me till this summer, when several have been discovered. It is difficult to get these out of the rock. Several times when stones have been split one of these large coiled up forms has appeared with distinct convex surface in view, lead to believe that with a little care the whole could be taken out as a cast from its bed. I have been disappointed to find that the imbedded portion is so thoroughly connected with the rock that it cannot be dislodged from the matrix without injury.

The only way to secure a good specimen when a portion of it is seen in relief is to take the fragment of rock in which it is found.

40. Endoceras—Many siphuncles of this genus have been obtained, and some segments, fragments of very large forms. Several of the siphuncles are fully 2 inches in diameter, and in the segments obtained the eccentric position of these is distinctly seen. A large specimen of this genus was found in the quarry near East Selkirk. Though imperfect it was over 2 feet in length and 3½ inches in diameter. The segments were well defined and the siphuncle was distinctly colored dark brown, while the rest of the fossil had the common color characteristic of this limestone. In some of the specimens the peculiar form of the septa resembling a series of funnels placed one within the other is quite distinct.

EXPOSURE 5.

We now pass from exposures seen on or near the banks of the Red River to some at quite a distance from it. The first I shall direct your attention to is what is known as Stony Mountain, of which the following is a sketch:

(A Sketch Map of Stony Mountain was on exhibition, showing its position and outline.)

At this place, located 13 miles north-west of Winnipeg, an excellent exposure of silurian strata occurs. The so-called mountain stands like an island of limestone raised above the surface of the surrounding prairie some 60 feet. The preceding exposures have all been more or less on the level and have come into view by removing the drift deposit and quarrying into the rock, but here we have an exposure raised high above the level and the rock distinctly seen without further work.

It is several miles in circumference and resembles in outline the shape of a horse-shoe. The west and north sides are quite steep, and along the escarpments the exposed edges of the strata are easily observed, while the east gradually slopes to the prairie level. There is every appearance of the west side having at one time been almost vertical, the work of some great denudating agent. Whether water as a wide river extending between this and Stonewall where the rock seems to be also worn away on the side nearest Stony Mountain, moved on with a strong current and eroded this side of the rock, or that it was worn away by the action of a glacier is a matter for conjecture. So peculiar is this isolated patch of strata that some have even thought it was not *in situ*, but to have been moved by some great force to its present position. The more it is examined the more likely it appears to have been the work of denudation.

At the southwest corner of the mountain the rock reaches the surface. Midway on the west side are located the extensive quarries and limekilns of Mr. McAllister.

These show a fine exposure, which supplies an excellent condition for examination. The rock face is several hundred yards in length, and in some places over 16 feet in depth. Layers of jointing and stratification render it comparatively easy to quarry. As the face is cut down and removed, the drift, here about 4 to 6 feet, is thrown into the quarry, and new rock worked out, so that there is seldom more than 16 feet of rock, chiefly in layers about 3 feet thick, in view. A few boulders appear in the drift, principally gneissoid. The rock surface after the drift is removed shows excellent traces of glacial *stria*

running in a N. NW. direction. There is a slight dip of the strata to the southeast. The lime from this stone, though not so white as that obtained from the Selkirk, has the reputation of being much stronger and better suited for building purposes.

The rock is very hard and flinty, and is not affected by cold Hydrochloric acid, but on heating violent effervescence takes place. Two distinct kinds of rock are observed at the escarpment on the southwest side: one the hard dolomitic limestone of brownish-grey color, about 40 feet thick; the other a reddish-grey limestone with clayey partings, about 10 feet thick. This layer effervesces with cold acid. It is very fossiliferous, and contains a great many brachiopod shells. The upper and hard rock contains very few fossils. Those found are chiefly coral and very obscure, and usually present a somewhat rusty appearance. The small rusty-like cavities seen in this layer almost invariably contain the obscure remains of coral which seems allied to the genus Favosites. In some parts of this upper layer the rocks have quite a rusty appearance, but in others the stone is a light clay color, and of a hard compact nature.

The stone from these quarries above the reddish layer is used in large quantities for building, but owing to its hardness it cannot be "dressed" as readily as that from Selkirk. Consequently the city obtains most of the ornamental stone from Selkirk, and the building from Stony Mountain.

The following is a vertical section of the rock as observed during the digging of a well at the southwest part, upon which the Provincial Penitentiary is located:—

1. 20 feet solid hard stone like that at the quarries.
2. 4 " thin layers of the same.
3. 2 " solid rock.
4. 6 " thin and broken.
5. 8 " yellowish rock quite ochreous.
6. 10 " reddish layer full of fossil shells.
7. 60 " a mixture of yellow and red containing some flinty material. Quite close to the west side of the escarpment some 300 yards from the penitentiary another excavation was made and the red rock was again found to occupy a position about 40 feet below the surface. It is from the debris thrown out of this that the writer obtained his specimens.

Fossils are very readily found at this place. The weather acts upon the soft stone and separates them out in a very fine state of preservation. This results from the fossils being composed of much harder material than the deposits in which they are enclosed. Small fragments of stone only a few inches in length will sometimes be found with six or seven very complete forms of different species.

These are chiefly shells in striking contrast with the corals and Cephalopods of Selkirk rock.

Following along the escarpment on the west side you can trace this reddish deposit quite easily. The action of the weather reddens it and when pulverized as it is in some places where the path touches, it is very like red ochre, and the small shells found in this dust are also red. Some of the hard rock has a most peculiar appearance, filled with cavities which present conditions as if derived from heat. But by far the greater part of this stone is a fine grained compact hard rock.

EXPOSURE 6.

Lying about 8 miles south of the outcrop just described another slight elevation above the prairie level occurs. Approaching this from the east a small clump of trees is observed in striking contrast with the treeless prairie around it. Numerous large boulders, principally gnessoid lie on this elevation. Good exposures of rock are shown at this place, where quarries have been opened from which stone has been quarried in considerable quantities for the manufacture of lime and building purposes.

About 5 feet of loose drift overlies the solid rock. This contains quite a number of large limestone boulders. The stone is very hard, in some cases almost flinty and in many respects the same as that of the upper layer at exposure 5. It shows little or no action on treatment with cold acid, but on heating slightly, effervesces readily. The rusty color in the stone is also observable here.

Fossils are comparatively scarce. There are many obscure remains which are, no doubt, corals, some allied to Zaphrentis and some to Favosites. In the stone of this place are found what appears to be the remains of plants, likely algæ. The stems are qute distinct, and are sometimes found in considerable quantities. These apparent stems vary from 3 lines to an inch in diameter.

They are found in a layer about 7 feet below the surface of rock. This stone in some parts shows a very distinct green coloring matter which, in several cases, coated the stemlike remains.

At first it was thought this might be caused by a fungus, although it seemed almost incredible that such could find its way to this layer so far below the surface. Examination does not seem to bear out this supposition. Another conclusion was that it might be a copper compound, but chemical tests have shown this to be a mistake. It may possibly be a silicate of iron. The coloring matter is quite thin and does not extend into the portions upon which it is found. It has been observed to coat several of the stem-like fossils, and also in some cases to form a more or less expanded appearance, but always in comparatively small patches On one occasion a coral was found coated with the same. The quarrymen speak of having found a "green snake" petrified in the quarry, and maintain that there is no doubt but it was a snake. This likely has been one of these colored stems, and bears out my own experience that the coloring matter is frequently associated with these fossils.

The layers in the quarry are quite horizontal and show no signs of disturbance. The following is a vertical section of the last quarry opened:—

1. 4 feet loose material with limestone boulders,
2. ½ foot showing glacial striæ.
3-4. 1½ and ½ foot in thickness, and of yellowish color.
5. 2 feet thick. Fossils in the vicinity of this layer, especially below.
6. 3 feet, with stemlike impressions, most commonly casts.
7, 8, 9. 3, 1¼ and 1¼ feet, layers of hard rock.

Some of the thicker layers thin out towards the east. The surface layers are easily broken. Even the solid rock below is readily worked. There is no appearance of the reddish fossiliferous layer of Exposure 5 in this quarry. It likely underlies the rock at a greater depth than what has been exposed.

Fossils obtained from the reddish-grey deposit 40 feet below the surface at Stony Mountain :—

PLANTÆ.

1. Palæophycus.—Obscure markings of plant life.

CŒLENTERATA

2, 3. Chætetes delicatulus (Nicholson) and C. lycoperdon (Hall.)—Especially the latter are represented here.
4. Ptilodictya acuta (Hall.)—A few specimens.
5. Streptelasma corniculum (Hall.)—Very common.
6. Zaphrentis.—A species comparatively common and characteristic. In outline resembles Zaphrentis, but possesses a marked tri-lobed appearance. On the curved side a transverse section is convex, but on the outside a distinct ridge is shown marked off by depressions along each side. This is no exceptional character, for the writer has obtained several specimens, usually about three inches in length, and all possessed the uniform tri-lobed condition.
7. Favosites.—In hemispherical masses, but the walls of the corallites so indistinct that no mural pores are discernible. Several fragments have been found which are likely of this species. Some small forms have been found which bear a marked resemblance to
8. Favistella favosidea of Hall. These usually occur in small, irregular masses.

ANNULOIDA.

9. Represented by Crinoid stems. These are smooth in contrast with those obtained at Selkirk.

ANNULOSA.

10. Cheirurus icarus (Billings.)—Glabella found.
11. Calymene Blumenbachii (Brogniart.)—Head found showing the eyes distinctly.

MOLLUSCA.

12. Orthis testudinaria (Dalman.)—Exceedingly common.
13. Orthis subquadrata (Hall.)—Common.
14. Rhynchonella capax (Conrad.)—Very numerous.
15. Strophomena nitens (Billings.)—Common.
16. Strophomena Hecuba (Billings.)—A well defined specimen.
17. Strophomena.—A smooth form but quite different from *nitens*. It is larger, more convex and not so well defined. Several have been found, all of uniform character.
18. Murchisonia gracilis (Hall.)—Several specimens. There are also a larger and coarser species of this genus common.
20. Pleurotomaria.—Members of this genus common.

21. Ormoceras.—The beaded siphuncle of a member of this genus.
22. Cyrtoceras.—The fragment of a curved cephalopod. Six segments are present. The diameter is five inches, and the general outline indicates a curved form of the shell, and no doubt belonging to the genus mentioned.

FOSSILS FROM THE UPPER BEDS OF STONY MOUNTAIN.

In nearly all cases these are very obscure, and cannot be identified beyond very general characters. Two species of coral are evidently present, one apparently allied to Favosites, the other to Zaphrentis. Besides these some fossils have been obtained which, no doubt, belong to the interesting genus—Beatricia—represented here by two species, of which several specimens have been found.

EXPOSURE 7.

This is found at Stonewall, 20 miles northwest of Winnipeg, and is considerably higher than the "mountain" of Exposure 5, though it does not rise abruptly above the surrounding district. Here a large quarry has been opened up which covers an area of four acres. Traces of glacial action are very marked upon the surface. *Striæ* running in a N. NW. direction are seen for many yards, and so distinct that the most casual observer could not fail to be attracted by the uniform markings. The floors of several cellars in the village near by also afford examples of striated rock.

Here the *drift*, which is about seven feet deep, has been removed and foundations built upon the solid rock. The cellars under the buildings have floors of smooth, polished and striated rock, illustrating in a most striking manner glacial action.

The *striæ* is in the same direction as at the quarry, N. NW. The stone from this place is entirely different from what has been described. It is hard and cherty, very white and effervesces but slightly on the addition of cold acid. When burnt it produces an exceedingly white lime, largely used by plasterers for finishing. Although apparently containing numerous fossils, they are restricted to but few spaces. The strata of this outcrop show no dip, present a very uniform condition wherever they were examined. No coloring matter is observed in the upper layers as in much of the rock at Exposures 5 and 6. This quarry, having been worked for considerable time, there is an excellent opportunity afforded for observing a vertical section, which may be represented as follows :—

Layers.	North Side.	South Side.
1.	1½ feet loose material.	1 foot loose material.
2.	1 foot rock.	1⅙ feet rock.
3.	1 " "	1⅓ " "
4.	2 " " Very uniform in	2 " "
5.	1¼ " character.	3¼ " much broken & in thin layers
6.	1 " "	5 " light red color.
7.	3 " " contains numerous specimens of coral.	4 feet, quite red and hard, but when exposed to the weather breaks up. It contains no fossils.

On the south side the layers are much thicker than those on the north, and

more rock is thus exposed. At this part there is a large open well, on the sides of which the nature of the stone can be perceived. This enables the observer to see more rock than in other parts of the quarry.

Farther north on the ridge another exposure occurs. Here, layer 5 of the south side reaches the surface, and on one side of the ridge at this quarry where a well was dug, the first rock met after passing the drift, 28 feet deep, was the red layer 7, although the level of the surface was comparatively uniform. This seems to indicate denudation of the upper strata probably by a river or glacier passing between this place and exposure 5, (Stony Mountain) which would form an opposite bank for the mighty stream. Whatever fossils occur in this white limestone of Stonewall they are difficult to secure except in small pieces on account of the stone being so hard and sharp The shells are very obscure, and though remains of primeval life are comparatively common, yet well defined specimens are rare. The following embrace the principal fossil types found by the writer in the clear white limestone of this place, more interesting for the evidence of glacial action it displays than fossils it contains :

1. Palæophycus.—Innumerable remains of plant-life are present. These are usually smooth and of uniform character, sometimes 2 or 3 feet in length, but never showing a branched form or surface markings of any kind.
2. Favosites.—Corals of this genus are very common. Mural pores and tabulæ are well marked. Although specimens are numerous still it is difficult to obtain anything more than a small fragment.
3. Strophomena. —Several imperfect specimens found.
4. Murchisonia.—One very interesting specimen of this genus was obtained.
5. Pleurotomaria.—This genus is represented by small forms.

Further investigation of this hard flint like stone will likely be rewarded with several forms, but there will always be more or less obscurity about them, in striking contrast with those obtained in the soft stone of Selkirk and the readily "weathered" of the lower layer at Stony Mountain.

This completes the description of 7 exposures of Silurian strata in the Red River Valley. These present four groups of rocks possessing marked differences in their lithological and palæontological characters, and may be represented in the following summary :—

SELKIRK ROCKS. EXPOSUSES 1, 2, 3 AND 4.		STONEWALL. EXPOSURE 7.	
Condition.....	Compartively soft.	Condition.....	Hard and cherty.....
Action of cold acid	Effervesces readily.....	Action of cold acid	Slight effervescence.....
Color.....	Mottled light grey.....	Color.....	Very white.....
Fossils.....	Very numerous.....	Fossils.....	Several.....
Types	Corals and Cephalopods...	Types.....	Corals.....

STONY MOUNTAIN.
EXPOSURES 5 AND 6.

	Lower Beds.	*Upper Beds.*
Condition.....	Soft.....	Very hard.....
Action Cold Acid	Strong effervescence.....	None, or very little.....
Color.....	Reddish grey.....	Clay, and yellowish.....
Fossils	Abundant.....	Few.....
Types.....	Brachiopods.....	Corals.....

The relative position of these beds apparently seems to be in the following order, the lower mentioned first:—1, Selkirk; 2, Reddish layer of Stony Mountain; 3, Dolomitic layers of the same: 4, Stonewall.

Regarding the geological horizon of each, it is difficult to arrive at a conclusion further than that the fossiliferous are decidedly Lower Silurian. The Selkirk rock has a most comprehensive group of fossils, there being representatives of several beds, but taking them as a whole the Trenton fossils are best represented. The rocks at Lower Fort Garry seem to indicate a transition bed between those of East Selkirk and the lower layer at Stony Mountain. They contain forms common to both. The fossils of the lower layers at Stony Mountain bear a marked resemblance to those found in the Hudson River group elsewhere, while the higher dolomitic beds and those of Stonewall probably border on the Niagara formation.

From these rocks upwards of 50 species have been obtained belonging principally to the Corals, Brachiopods and Cephalopods, together with some doubtful forms, such as Receptaculites, Beatricia and Stromatopora. The number and variety of fossils from these exposures indicate rich results to future investigators, and it is hoped will occupy the attention of members of the Historical and Scientific Society from time to time.

RED RIVER VALLEY.

Its Geology discussed before the Historical Society.

SCIENTIFIC VIEW OF THE SURROUNDINGS OF WINNIPEG.

WHERE THE CITY'S WATER SUPPLY SHOULD BE OBTAINED.

OBSERVATIONS ON THE COAL AND OTHER IMPORTANT QUESTIONS.

The regular meeting of the Historical and Scientific Society, Thursday evening, Dec. 28th, was well attended, and interest even greater than usual was manifested in the proceedings.

THE PAPER OF THE EVENING.

Mr. J. H. Panton was then called upon to read his paper Gleanings from the Geology of the Red River Valley, which follows:

Mr. President and gentlemen: To-night for a short time, we purpose directing your attention to the Book of Nature, and from the fragmentary leaves of the geological records glean something about the rocks beneath our city, and the loose material which overlies them. Rocks may exist in two forms, the solid, which is represented here some fifty feet below the surface, and the pulverized, which, mingled with decomposing vegetable matter, forms the soil of our fields. The solid form is fixed, and has not been removed from its present position since deposited, while the pulverized has in most cases been derived from rocks at a distance. These have been ground down and transported by agencies to which reference will be made afterwards. To say something regarding the nature of these rocks, as they form the foundation of this city, is our object in appearing before you to-night.

The geology of our great North West, like our vast plains and immense rivers, is on a magnificent scale. To the eye of the geologist a grand vision appears, as he contemplates the marvellous panorama that rolls before him, portraying the geological features of the country lying between the Laurentian rocks to our east, and the lofty mountains of the west. The former, representatives of the first rocks to triumph over the universal waters of primeval days and the latter belonging to a period near the summit of the geological series. Between these great natural boundaries, we see stretching before us, the three vast prairie steppes of the North West, rising in succession above each other and distinguished by characteristic physical features.

FIRST PRAIRIE STEPPE,

Known as the Red River Valley, is 52 miles wide at the international boundary line, widening to the north, with an elevation of 800 feet above sea level and embracing an area of 6,900 square miles or over 4,000,000 acres. The last of our country to emerge from water, it has received a rich compensation in the drainage of the North West for countless years, a rich alluvial deposit to which the eyes of the World are turned with astonishment at its almost inexhaustible fertility. In this rich valley abundant harvests are reaped upon fields which have been sown for fifty successive years with wheat, and as yet show no indication of less productive power.

Since our geological gleanings are to refer more particularly to this deposit, as it occurs beneath and around Winnipeg, we shall not dwell at present upon an area

fraught with a great future to the inhabitants of Manitoba.

SECOND PRAIRIE STEPPE.

Following upon the first, the Second Steppe appears with an elevation of 1,600 feet, 250 miles wide at its southern limit and narrowing slightly towards the north.

Within this vast area, are 10,500 square miles of land, more rolling in its character than the preceding district, but also containing vast stretches of prairie land.

The deposits here differ from those of the first steppe, both regarding age and nature. Silurian strata immediately underlie the silty material of the Red River Valley, while throughout this region Cretaceous outcrops belonging to a period of much later date occur. Great stretches of arable land here too, lie spread before us, affording ample room for millions of pioneers ready to possess the land.

In the prolific fields of these extensive acres, industry and economy cannot fail to meet with enviable success to those who are now joining in the advancing tide of settlers across their boundless plains.

THIRD PRAIRIE STEPPE.

Crossing our plains we finally reach the third great table land of the North West, 465 miles wide on the forty-ninth parallel with an elevation of 3000 feet. It embraces an area of 134,000 square miles.

In this immense area lie our vast coal fields, so extensive that the term *Lignite Tertiary Plateau* has been applied to the region. Nearly all of the coal exposures referred to as occurring in the North West, are found in this district. As further investigations are made concerning the nature and extent of this coal bearing strata, it will be found that plenty of fuel will be supplied with but little difficulty to the future occupants of the treeless prairie land to the east.

Besides the great coal deposits of incalculable value, Vast stretches of heavily wooded districts, belts of arable land and rich pasturage areas, occur throughout the region.

As this great scene sweeps before us, shewing in succession these marked natural steps, each full of interest sufficient to supply material for a long paper, we can perceive what an attractive country this is to the enthusiastic student of nature. The rich ores of the Laurentian rocks eastward, just being unearthed are attracting thousands to seek the hitherto hidden treasures of that place. The lands of almost exhaustless fertility in the Red River Valley are rapidly being occupied. The rolling districts of the second plateau with drier and warmer soil, are eagerly sought after by the practical agriculturist. While the Third Steppe with an inexhaustible store of fuel, scarcely hidden beneath the surface, will not be less attractive as a supply to the inhabitants of woodless districts. But our work is confined to a narrower limit and our attention must be confined more particulary to some remarks on the geology of places less remote than those interesting regions to which reference has been made.

As the pioneer in our country wanders over the prairie, anxiously seeking for the surveyor's stakes, in order to enable him to locate his homestead, so we have been looking around for geological landmarks, which will enable us to ascertain our position in the series of geological strata.

Our rich alluvial soil has supplied some information, but it was not until we had ascertained the depth and nature of drift material below us, and the character of the rock over which it has been spread in ages long receded into the past, that we have been able to open the stony records at the proper place, and ascertain our relation to the past.

It is a recognized fact, that the earth's crust is composed of many layers.

These are grouped into Formations known by certain names, which are often taken from the locality where the formation is well represented, as Trenton, Hudson River, Devonian, or it may be from the nature of the rock, as Red Sandstone Gypsiferous, etc. The formations have their characteristic fossils, consequently when we find these we can arrive at a

pretty sure conclusion regarding when and how the formation was deposited, as well as the nature of the deposit. Another important fact concerning the formations is that they always occupy the same position relative to each other. For example, if we represent the formations by 1, 2, 3, 4, etc., the lower numbers occupying the lower position, we shall never find 3 be ow 2 or 8 below 5. Some may not be represented in certain localities, there may be no 4, 6, 7, but if we find 3, 2, 5, 1 they will occupy the position 1, 2, 3, 5. From this it will be readily understood that as soon as we obtain a few characteristic fossils in the neighborhood of a place we can, with considerable certainty, make out the position of the rock in the geological series. At Stony Mountain, along the Red River in the Parish of St. Andrews, and at the C. P. R. round house near Selkirk are found outcrops which supply fossils peculiar to what is known as the Hudson River and Trenton formations, largely developed in the State of New York and in Ontario, especially in the vicinity of Toronto and east along the north shore of Lake Ontario. These outcrops, no doubt, belong to the same rock as that which is found some 50 feet below the surface at Winnipeg. The characters of the deposits at Stony Mountain are closely allied to those of the Hudson River formation in other localities, while the buff-colored magnesian limestones of the Red River Valley are likely representatives of the upper part of the Trenton limestone. Both formations belong to what is commonly known as the Lower Silurian Series.

FOSSILS OF THE SILURIAN AGE.

Before a stratum of rock can be formed, in most cases it is necessary that the place upon which it is laid be beneath a body of water, especially when the rock contains the remains of marine organisms. Now, since we have a good stratum of Silurian rock some 50 feet below the surface, cropping out west and north of us, we may assume that at one time this part of the country has been submerged and raised again from the waters which covered it. On an examination of the rocks at any of the outcrops referred to, you are almost certain to find some traces of primeval life some bear a close resemblance to shells of our own day, some not unlike the backbone of fish, while others are readily recognised as corals. All these peculiar remains are traces of animals, which occupied the waters when the site of Winnipeg was the floor of an ocean.

These creatures dying their bodies became entombed in the muddy bottom, afterwards petrified and as fossils have come into our possession, serving as keys to unlock the hidden secrets of the past. As these animals, now known only by fragments of rock resemble those found only in salt water at the present time we at once infer, that the waters which covered this place in those early days were of a briny nature. Pursuing the same line of thought we can readily assume that in those days the climate was much different from the present. For as already mentioned among the inhabitants of our early sea were corals, a group of animals that can exist only in waters which have a mean temperature of 60 degrees.

The wedge shaped fossils, which usually show a series of rings with a sort of rod running through their center are called Orthoceratites. they vary in size from a few inches to three feet in length. They are the remains of animals, which lived in shells consisting of many chambers, the last being occupied by the animal, a representative of the cuttle fish family.

Many of the shells found are readily identified as belonging to both groups of mollusks, those with univalve and bivalve shells. Among the fossils of our rocks are some of wormlike form. They vary from one to several inches in length. These are the stems of what are known as stone lilies. The stone lily is what remains of an organism, which flourished in the seas of the past. Attached to the sea bottom by the expanded base of a jointed stem and surmounted by a flowerlike expansion, it bore some resemblance to a closed lily, especially when the tentacles of the animal were folded in. They seem to have been very numerous, for large portions of rock are found made up almost entirely of these crinoid stems, not uncommonly called Encrinites. It is a rare thing to find a complete form, though at almost every outcrop innumerable fragments of stems are found. We have now to call your attention to a fossil not common here, but some fragments have been found.

not unlike a butterfly with expanded wings, is only a fragment, and represents the tail of the organism. Fragments of this nature are common, but complete forms, such as the specimens before you, are very rare. This fossil belongs to a type of very unique organisms common in the Silurian seas. From the trilobed appearance of the animal it has received the name Trilobite. These creatures seem to have been able to curl themselves up, either for protection or to enable them to sink more rapidly. So complete has the process of replacement gone on in some of these trilobite fossils that in many cases the structure of the eye is accurately preserved as can be seen by examining the specimens before you, which show all the parts very distinctly. Some peculiar, tiny saw-shaped markings also occur on the rocks of the Hudson River formation; these are known as Graptolites. Upon the tooth-like projections small cups were situated, each of which contained a small organism of very simple structure. A whole colony of these creatures were located upon the axis, and with their tiny tentacles were able to whip food into their rudimentary mouths. These fossils occur in a variety of forms, some with a single row of tooth-like projections, others with a double. Many are not unlike a leaf and a few consist of many axes radiating from a common centre. The Graptolites and Trilobites are of especial interest in determining the age of a deposit. As yet none have been found in strata above the Lower Carboniferous, consequently when we find them on the surface we know at once that we are below the coal measures, and as far as coal is concerned we will seek for it in vain. Coal may appear above these fossils, but it has not been found below them. All these creatures, which inhabited the sea in those early years of the world's history have long been extinct, though at one time they seem to have thronged the sea in myriads.

The animals to which reference has been made were among the leading types then in existence; for at that period in creation no insects, no fishes, no birds, in short, none of the higher animals had as yet made their appearance. Life was confined chiefly to the sea, and of a very rudimentary nature. The only plants were seaweeds, and, as noted, the animal kingdom was but scantily represented, the genera and species were limited, but the individuals were very numerous. Up to this time stillness was a leading feature in nature. No sound was heard except the lashing of the waves on the lonely shores, or the howling of winds unimpeded in their course across the bleak and solitary rocks. The continent, like its species, was submarine in its mode of existence. It was outlined, but not till long periods had passed, during which great physical disturbances took place, was the present form brought into existence. Such was the dumb state of affairs when the rocky foundation of our ambitious city was laid.

THE WINNIPEG DRIFT.

Having directed your attention for a short time to the solid rock lying beneath our clay deposits, it now remains to consider briefly some things in reference to this loose material, and endeavour to explain how it has been formed and reached here in the finely divided condition we find it. The presence of boulders in this so-called drift material, of the same composition as rocks north and east of us, and the salty nature of much of the water found in some wells would seem to indicate that our soil has been derived from other sources than the disintegration of the rock beneath, and that much of our clay is an alluvial deposit brought here in past ages from districts quite remote from Winnipeg. From an interview with Mr. Piper, known as having an extensive experience in well boring throughout the city, we have learned that the average nature of a vertical section of the deposits, overlying the solid rock here is as follows:

1. Surface mould, one to four feet, dark color and exceedingly fertile.

2. "Yellow gumbo," two to three feet, a very sticky form of yellowish clay which usually holds considerable water.

3. Dark gray clay, thirty to fifty feet, with boulders scattered throughout, some of them four feet in diameter, and chiefly gneissoid, and no doubt derived from Laurentian rocks.

4. Light-colored clay, one to three feet, containing many small stones.

5. Hard pan, two to ten feet, a very solid and compact form of clay.

6. Sand, gravel and boulders, five to twenty-five feet.

7. Angular fragments, one to three feet, usually limestone, and largely derived from the solid rock which lies immediately below it.

This loose material is far from being uniform, and varies so much in its arrangements that scarcely any two borings show the same distribution. Sometimes there is little or no hard pan, while in other parts it is several feet thick. However, as a usual thing, these seven forms of strata are passed through in boring, and varying in thickness to the number of feet already mentioned.

SERIES WANTING.

After the formation of the Hudson River limestone, there seems to have been a great break in the deposition of rock in this part of the country, for in other parts of the Dominion we find hundreds of feet in thickness, being deposited while the Red River was, geologically speaking, at a stand still. Such might have happened by its being raised above the sea and continuing so, while other places were submerged and in a position to receive further additions to their strata. It may have been, though not likely, that deposits were laid down and afterwards disappeared by denudation during long periods of time, or as some have thought the place may have been located in deep water and situated far beyond the reach of deposits being added, while they were forming rapidly nearer the shore. The first reason for the absence of deposits, is that which we are inclined to accept. Whatever view may be the correct one, is open for consideration, but one thing is certain, formations of later date are represented elsewhere, while here not a trace of them is found. Throughout the coal forming age little or nothing was being added to our strata, while other places were receiving from Nature's liberal hand donations, which would serve as fuel in time to come. True, coal has been found in the North-West, and lately we have been informed by some of our eager news seeking reporters it has been discovered near Selkirk But it must be remembered that our coal belongs to a much later period than what is known as the "Coal Measures." The latter are supposed to have been deposited toward the close of the Paleozoic age, while the former belongs to the Cainozoc or Tertiary period: in other words, using the terms Primary, Secondary and Tertiary as applied to the various comprehensive periods in geological history, we find the "Coal Measures" in the Primary and the Lignite of the North-West in the Tertiary.

The extensive Coal age passed away without the Red River Valley receiving a single seam. The age of Chalk ended, and still our strata were not increased. Whole formations thousands of feet in thickness were built up and millions of years passed away while the rocky foundation of Winnipeg seemed to idly wait without further addition, beyond the influence of the sea. Still the surface of our rock would be undergoing some changes. Winds may have exercised an influence in disintegrating the rock. Rains, too, may have battered upon the exposed surface now no longer beneath the sea. The action of these forces, together with frost during the countless ages employed in building up immense rock formations elsewhere would aid to some extent in preparing the ground material of which our soil is composed and which at present hides our solid rock from view. But now, after a great portion of the first geological age of the world, the whole of the second, and much of the third had passed away, and millions of years had glided by, we find a new scene about to take place, in which this part of the Dominion performed no insignificant part.

THE GLACIAL AGE.

We have now reached the glacial period in geological history, a time when mighty icebergs and immense rivers of ice are supposed to have swept over the northern part of our continent, wending their way southward, loaded with thousands of tons of rocky material, and grinding the rocks over which they passed. It is supposed that during the glacial period the northern portion of the country was raised above the level of the sea, so much so that a line of perpetual snow was formed. Where such occurs snow must accumulate, till finally the force of gravitation starts the mass. This is the origin of a glacier or ice stream. Its movements may be slow, sometimes only eight or ten inches per day, consequently it will be a long time in making much headway down the moun-

tain side; but onward it moves with irresistible force grinding over everything in its course—one gigantic body of ice, sometimes miles wide and 600 to 700 feet thick. Such a glacier can be seen at the present time in Greenland. If the snow line is only one or two thousand feet above the sea level, the glacier from it reaches the sea before the temperature of the lower region is sufficient to melt it. This immense body of ice will continue pushing out into the water grounding upon the sea bottom until the depth of the water is sufficient to float it. As soon as this occurs portions of the glacier will break away and float off, forming what are known as icebergs; hence, the origin of icebergs is, to a great extent, the terminus of a glacial stream whose mouth enters the sea. This phenomenon is now seen in countries far north, where the line of perpetual snow is near the sea. In such places glaciers appear issuing from the mountain tops, passing onward through valleys until they reach the sea, where the ends break off and float away as icebergs into warmer regions. But in countries where the snow line is much higher we notice different phenomena. The glacial stream never reaches the sea in the form of ice, for long ere it gets the temperature of the atmosphere has melted it, and a river of cold water flows into the country below, and becomes in many cases the source of a river. Such is the origin of the Ganges, which rises at the base of the Himalaya Mountains from the end of a glacial stream.

Could we examine the rocks upon which this immense body of ice has been grinding in its course, we would find it very much scratched and abraded. As the glacier moves on through the valley, portions of rock are continually dropping upon it from the heights above; consequently, where the the glacial stream is long, it is loaded with fragments of rock, which, in transportation, by continual grinding, become more or less rounded. If the glacier terminates before reaching the sea, these rounded pieces of rock will be deposited near its mouth and where it has contained for many years an immense heap of stones will be formed, which in years after when the aspect of affairs has changed, may have much the appearance of a gravel pit or line of boulders seen in some parts of the country.

GLACIAL DRIFT.

The question which presents itself now is, has this part of the Dominion experienced these phenomena, and if so, to what extent? If we were to remark on seeing a man's footsteps upon the sand that a human being had been there, no one would doubt it though years had elapsed since the person who made them passed that way. Just so with regard to glaciers being in the North-West. Their traces are here and though absent themselves have left silent monuments, which indicate their course from northern regions to those farther south of us. North and west of us near Nelson River, Knee Lake and places in that vicinity glacial strice, in other words, markings upon the rocks in the form of grooves, scratches and polished surfaces, such as are found upon rocks where glacial action is now going on, have been observed in over seventy-four places widely separated from each other. They all indicate a course from north to south, in a more or less south-westerly direction. Of all observed only three show a course south-east. North-west of us, in the vicinity of Lake Athabasca, especially at the western end the rocks present all the characteristics of having undergone glacial action. If the surface of the rock, which crops out at Stony Mountain, be closely examined we think that in some places glacial strice will be observed. In many parts of Ontario rocks with abraded surface are very common. So uniform and over such broad areas do these glacial markings occur that there can be no doubt as to their origin, especially when we remember that similar markings are being made on the surface of rocks in other countries which we know are now undergoing glacial action. See Greenland, Alps, Norway and Himalaya Mountains. Although our soil here is comparatively free from stones, still a little west of us many stones are seen which are not of the same composition as the rock below, but precisely the same as those lying north and east of us. By some agency or other they have been transported here, and as no view has yet been given to account for their presence so far south of

the original rock, we are forced to accept the theory that they have reached their present location through the agency of ice, either in the form of glacial streams or icebergs; that those gigantic bodies of ice at one time moved over this region of country loaded with rounded fragments of rock, some of which lie on the prairie west of us and many occur in the clay upon which Winnipeg stands. Not long ago we were shown a piece of rock which had been broken off a boulder sixty feet below the surface. It could be readily identified as a piece of gneissoid rock, such as occurs in northern districts. The soil which we cultivate dates much of its origin from this period, which is computed by Sir Charles Lyell to have lasted about 150,000 years, sufficient time to grind up much of the limstone below us and the rocks farther north. The material ground up during this long period of time would be scattered in post-glacial days by the torrents flowing down from upland districts to lower, no longer within the icy grasp of an Arctic climate. Still later, silty materials may have been laid down on the bottom of an inland sea, into which the drainage of a surrounding district poured, and thus be derived our deposits which overlie the rock below. The lower clay beds being a glacial and post-glacial deposit, while the upper largely lacustrine in their origin. From what has been said you will observe that the site of Winnipeg must have been at one time covered by the waters of a nameless sea, a sea along whose shores no mortal ever trod, a sea inhabited by animals extinct millions of years ago. Further, that it was raised again above the waters, and for countless ages its rocky surface exposed to the weathering action of wind, rain, snow and frost.

That either icebergs floated and stranded along the shore of a vast body of water, which again covered it, or that glacial streams, coming from the north glided along, polishing and abrading the surface of the rocks over which they passed.

WINNIPEG WATER.

After an interval of some time, this place seems to have been again submerged by the waters of an inland sea, the shores of which extended along the elevated ridge from Pembina to Riding Mountain. Into this great lake the rivers of the North West poured their muddy waters, charged with saline substances derived from deposits over which they passed. This may have continued for a long time, at least long enough to form the alluvial deposits of the Red River Valley, which we find now largely made up of finely divided clay, strongly charged with saline substances.

This inland sea has passed away, whether by subsidence of land north of us or the elevation of that on which we stand, we cannot say, but the fact presents itself that all that remains now is the river and the lake into which it empties, with a country on either side showing all the characteristics of a deposit which settled on the bottom of a lake no longer in existence.

Viewing the formation of the Red River Valley from this standpoint we can scarcely hope to get good water in our clay beds, which are no doubt impregnated with impurities derived from the river drainage of the saline deposits west and north of us. A comparison of an analysis of the Red River and that of the Assiniboine will at once show how widely they differ. In each case the number of grains in an imperial gallon is given:

	Red River.	Assiniboine
1. Organic matter	5.28	7.71
2. Calcium sulphate	2.42	4.39
3. Calcium carbonate	10.50	7.05
4. Iron, alumina, silica	3.78	1.09
5. Magnesium sulphate	. .	7.81
6. Alkaline salts, chiefly as chlorides	5.18	9.75

From an examination of this analysis it will be observed that the water from the Assiniboine contains 30.09 grains of solids in an imperial gallon, while that of the Red River contains only 21.88. The former carries down the drainage of the west, where many of the deposits are largely impregnated with alkaline salts, while the latter flows chiefly over rock composed of limestone; hence the Red River has more carbonates and less sulphates. The presence of so much magnesium sulphate and Epsom salts in the water of the Assiniboine is rather striking. If we wish to secure good water, we must bore through our impure clays into solid rock beneath, or bring it from a distance. Such might be obtained from Lake of the Woods, which is supplied from rivers whose drainage is over rocks of the Lau-

rentian series, upon which water has but a slight solvent effect and consequently of a purer and softer nature than that which has passed over limestone formations.

As already observed there are 30.00 grains of solids in a gallon of water from the Assiniboine 21.88 in one from the Red River, while in water from the Ottawa we find only 4.84 grains and that from the St. Lawrence 11.74. The Ottawa drains a country in which the rocks are largely of the Laurentian series while the others come more in contact with limestone rocks.

The hardness of these waters is represented according to Clarke's method as follows: Assiniboine, 10.5°; Red River, 9°; St. Lawrence, 3.5°, Ottawa, 2.3°.

This shows conclusively the marked difference between waters, both as to hardness and purity which have passed over rocks widely different in chemical composition, and that if we seek pure water we must have its source in rocks upon which water has but little effect.

PRACTICAL CONCLUSIONS.

Let us now sum up the practical information derived from the geological gleanings gathered from an examination of our solid rock and the material which covers it.

1. The constituents of our soil have been derived from the disintegration of Silerian limestone beneath, exposed to agencies at work during the countless years that preceded the glacial period after the deposition of these rocks, also from materials obtained by the grinding up of Laurentian rocks at a distance, during the glacial epoch and transported, in glacial and post-glacial days. To the ground up material of these long periods mixed with boulders, must be added the rich alluvial deposits brought down by rivers and spread over the bottom of a lake which seems to have covered at one time the whole Red River Valley. These materials, together with decomposed organic matter largely derived from plant growth of comparatively recent time, colored dark no doubt to some extent, by the charred remains resulting from repeated prairie fires, supply the constituents of a soil which, under the crucial test of the chemist, and the experience of the practical agriculturist has been proved to possess wonderful fertility.

The alkaline salts at present found in some parts of our Valley and apparently obnoxious to vegetation must pass away as the land comes under cultivation by skilled farmers. These substances being easily soluble, readily pass down into the sub-soil from which they will be carried off by a proper system of drainage and what may still remain will soon be exhausted by the proper application of manure.

The experience of the few farmers that have as yet tilled these patches with "alkali" shows that manure destroys it and that in Manitoba manure is valuable as well as in the impoverished districts of eastern provinces.

2. That most of the rounded boulders in our days and those on the surface west of us have been transported from rocks of the Laurentian series at a distance, through the agency of ice.

3. We need not be in suspense regarding a supply of good water to our city however large it may become. If the wells, with their sources, in some cases, in the sands of the lower strata in others, the solid rock, are not sufficient, can we not look forward to a time when the characteristic energy and enterprise of our citizens will undertake to have a supply brought from the pure waters of the Lake of the Woods to the inhabitants of the great metropolis of the North West! Water brought from Lake Winnipeg, as some have suggested, can scarcely be expected to equal that from the east since it connects with a system of lakes into which are now flowing, waters highly charged with salt and other mineral substances. These lakes receive the saline deposits brought by the river drainage of the west and which in early years reached here, so as to impregnate Winnipeg clays as we find them at the present time. Lake Winnipeg receives the waters of rivers

which drain an area of 400,000 square miles in parts of which are found pools and lakes containing salts of sodium and magnesium that must find their way into these waters and affect their chemical composition to some extent. The waters of the Red River are comparatively good, if rid of the suspended material. This is observed to be the case especially during the winter months when little or no mud from its banks dissolve and mingle with the stream. Another objectionable element likely absent to a great extent in winter is organic matter which is not so readily formed at a low temperature as during the summer months.

The mud and other suspended impurities of our river water might be easily got rid of by filteration, and very good water be obtained. The calcium carbonate in the water can scarcely be considered a deleterious substance. To some this is a necessary ingredient and nearly all spring water possesses more or less of this compound.

This brings to a close our Gleanings from the Geology of the Red River Valley. There are some things which we desire to investigate further, and when more leisure occurs, we may again trespass on your patience by giving additional evidence regarding the history of the country immediately surrounding Winnipeg, long before the advent of man upon the earth.

OBSERVATIONS BY MEMBERS.

A desultory discussion followed the reading of Mr. Panton's paper, in which remarks of more or less interest were made. Rev. Professor Bryce said there was a possibility of Tertiary strata being found on some of the islands of Lake Winnipeg in which coal might be found. Lumps of coal had also been taken from the Roseau River, an eastern tributary of the Red River, and some geologists had surmised that they had come from lignite coal beds in Tertiary strata formed in some phenomenal manner near the head-waters of the Roseau. The likelihood of coal being found in any quantity in either place was very small. He also spoke of the inferiority of the water of the Assiniboine to that of the Red, but pointed out the unsuitability of either for summer use. A supply would have to be procured from some other source. Mr. McArthur referred to the good quality of the water in two wells on the Red River that which did not reach the rock, and also asked a question as to the relative purity of water from flowing and deep wells. Mr. Panton suggested that the two wells spoken of, and the various flowing wells which gave pure water, must tap the quicksand underneath the hardpan, through which water percolates from the surface some distance away, outside the region in which saline properties abound in the earth. A gentleman in the audience remarked that wells sunk to the same bed of quicksand some distance away east of the Red River yielded water of the same purity. This water might therefore enter the stratum of sand where it was exposed in the shores of some of the eastern lakes, and be conveyed by it, underneath the hard-pan, to the point where the wells are sunk. In reply to a question as to petroleum deposits Mr. Panton said crude petroleum in quantities was not found in the Silurian rocks. Utica shale, a rock of the Trenton formation, which occurs at Oshawa, Collingwood, and other places in Ontario, is permeated with petroleum, but is not worth working. The great petroleum deposits occur in Devonian strata, and it is in rocks of this formation that the crude oil is found on the eastern shores of Lakes Manitoba and Winnipegoosis.

Another question was put in order to ascertain how it was that fish remains were found in the Souris District if as the lecturer had said our rocks were deposited before fish came into existence.

This was readily explained by remarking that in the Souris District the deposits were of a much later date than those around Winnipeg and that the presence of fish there was quite in harmony with the teachings of geology bearing on the strata of that region.

A vote of thanks to Mr. Panton for his paper, proposed by Mr. Whitcher and Mr. Ashdown was adopted. The President took occasion to congratulate the Society upon having the opportunity of listening to a paper prepared in so popu-

lar a form on so important a subject. Mr. Panton said that at some future time he would probably be able to contribute a paper on the evidence of the glacial period, as exhibited in the North-West. The President then announced that at the next meeting a paper would be read by the Rev. Professor Bryce on the subject, "First Across North America." The meeting was then adjourned.

A number of large illustrations of fossils found in the Silurian rocks aided greatly in making the lecture interesting and instructive.

The sketch showing the various strata of which the Winnipeg drift is composed illustrated very clearly their nature and arrangement.